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April 22, 2005

U.S. Environmental Protection Agency
Office of Water/Office of Science and Technology
Health and Ecological Criteria Division (MC 4304 T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Response to Region 4 White Paper

Dear Sir or Madam:

The American Farm Bureau Federation would like to commend EPA and the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force for conducting a review of the science and data underlying hypoxia in the northern Gulf of Mexico. We would like specifically to commend the many scientists at USEPA Region 4 for initiating a new Gulf study and for their efforts in reviewing the initial conclusions of the Committee on Environment and Natural Resources (CENR) Integrated Assessment of Hypoxia. From the standpoint of farmers and ranchers, the Region 4 report -"Evaluation of the Role of Nitrogen and Phosphorous in Causing or Contributing to Hypoxia in the Northern Gulf" - presents valuable data and analyses that differ substantially from the data and analyses presented in the CENR assessment reports (Rabalais et al., 1999; Goolsby et al., 1999; CENR, 2000). These differences raise many critical questions about the initial CENR findings. In addition to evaluating the Region 4 report, we emphasize the need to also evaluate the CENR reports.

We recognize that the nutrient control strategy adopted by the Task Force is based on CENR's adoption of the Redfield ratio as a tool for identifying relationships among biologically available forms of nutrients. We believe the Region 4 report shines much-needed light on a fundamental defect in the earlier assessment (i.e., that the northern Gulf is a system that is in approximate Redfield ratio balance). Reliance upon this faulty conclusion led inevitably to the idea that controlling nitrogen loads, especially from agricultural fertilizer application in the Midwest, would reduce excessive algal growth and midsummer hypoxia formation.

The Region 4 report points out major scientific discrepancies and emphasizes the need for EPA to resolve these differences through an open and impartial scientific review of <u>all</u> the existing science on <u>all</u> possible causes of hypoxia in the Gulf. Farm Bureau is encouraged that EPA is treating the implications of the Region 4 report with utmost seriousness and will seek to preserve and protect the credibility of both the scientists involved as well as the science underlying the health of the Gulf of Mexico and our coastal wetland ecosystems.

The following comments highlight specific scientific issues raised within both the Region 4 report and the Initial CENR Hypoxia Assessment that point to the need for additional data, analysis and additional research.

The Science

The Region 4 analysis raises important questions with regard to the underlying science of the biogeochemistry of the Mississippi/Atchafalaya, the northern Gulf and the original CENR assessment. Going forward, EPA should look upon this as a critical opportunity to rebuild with farmers and ranchers a relationship that was put to great stress by the original assessment. One of the most effective means of reestablishing such a relationship will be to start with an open and transparent evaluation of the scientific questions raised by Region 4's report with a goal of answering the questions raised by the Region 4 scientists. An illustrative list of such questions, which are discussed at greater length further on in this paper, follows:

- Why did the CENR reports use an inappropriate nutrient ratio as a basis for evaluating the roles of nitrogen and phosphorous in causing hypoxia, and for setting the scientific basis for nitrogen control?
    - What mechanisms will be in place to assure farmers and ranchers that future control strategies will be based on sound science that reflects the complexities of the Gulf's problems?

- Why was the limiting nutrient not clearly identified, as was recommended by a number of comments to the original CENR assessment and Hypoxia Action Plan?

- Why were nutrient data for stations below St. Francisville not used in the original CENR assessment?

- Why were data from 1994, 1995, and 1997 nutrient concentration for Transect C in the Gulf of Mexico not included in the CENR assessment?

- Why did CENR base its assessment and Action Plan on an inadequate monitoring program?

- Why did Goolsby et al. (1999) not analyze elemental nutrient ratios in the Mississippi/Atchafalaya River?

- Why did CENR not adequately consider the relative contributions of other potential causes to hypoxia in the northern Gulf? For example:

    - Significant changes in the flow of the Mississippi and Atchafalaya Rivers.
    - Prescribed flow requirements with regard to the Mississippi and Atchafalaya Rivers.
    - Significant changes in the hydrology of coastal Louisiana.
    - Significant loss of coastal wetlands and the "walling off" of coastal Louisiana.
    - Nutrient contribution of all major point sources.
    - Nutrient contribution from the deep ocean.
    - Influence of resource extraction on the environment and ecology of the Louisiana and Texas continental shelf.

Issue #1

Why didn't the original CENR task force use the accepted Redfield ratio formula?
Albert Redfield established the so-called Redfield elementary ratio (106C:16N:1P, by atoms) based on the concentrations of dissolved inorganic nitrogen and dissolved inorganic phosphorus. Although Redfield's analysis dealt exclusively with nitrate to phosphate ratios, it has become common (and accepted) in the literature to include all forms that dissolve inorganic nitrogen (nitrate, nitrite and ammonia); thus, DIN to DIP ratios are now most commonly used and are used in the Region 4 paper to evaluate elemental ratios in the Mississippi/Atchafalaya River and seawater. Significant deviations from the Redfield ratio provide information on the potential for one nutrient to be used up by phytoplankton while leaving "surpluses" of other nutrients. Elemental ratio information is often useful for contributing to decisions regarding nutrient management strategies to control the excess growth of phytoplankton.

The Region 4 report points out that the Redfield ratio is dissolved inorganic nitrogen to dissolved inorganic phosphorus (DIN/DIP) and that Rabalais (the lead scientist in the initial CENR assessment) used the ratio of dissolved inorganic nitrogen to total phosphorus (DIN:TP). In subsequent literature, Rabalais acknowledged … that the "Redfield ratios (Redfield et al. 1963) are the elemental ratios that aquatic organisms tend to require for sustained growth, e.g., a 16:1 DIN:DIP for phytoplankton…" However, the Region 4 report questions why Rabalais used the ratio of dissolved inorganic nitrogen to total phosphorus (TP), noting that this ratio (DIN:TP) has never been used in a ratio that was referred to as a Redfield ratio, and no rationale for using this ratio is given.

An extensive scientific review related to phytoplankton production and hypoxia provide no other instances where dissolved inorganic nitrogen and total phosphorous (as opposed to inorganic phosphorus) was used for the computation of the Redfield ratios. One must conclude that the CENR Report concluded, in error, that the waters in the lower Mississippi River are "in nutrient balance" based on DIN/TP analysis. Farm Bureau believes strongly that this issue, and the underlying implications regarding the bioavailability of nutrients and which nutrient is the limiting nutrient, is at the heart of this scientific controversy and must be resolved.

Issue #2

Is phosphorus or nitrogen the most important limiting nutrient in the lower Mississippi and Atchafalaya River in spring and early summer?
The CENR reports recognize that it is high primary productivity in the spring and early summer that fuels mid-summer hypoxia. The Region 4 report states that phosphorus is the nutrient that potentially controls primary productivity and mid-summer hypoxia in the northern Gulf of Mexico. These findings have major policy and resource management implications.

The Region 4 report highlights the inconsistencies and conflicting views presented in the Gulf of Mexico hypoxia literature.

1. One view holds that most of the primary productivity (algal growth) in the Gulf of Mexico that contributes to hypoxia occurs under mostly "Nitrogen Limited" conditions.

a. This view, *advanced in the original CENR report*, was that the lower Mississippi River is in “Almost Perfect Redfield Ratio Balance;” and

b. The obvious and primary answer to the Gulf hypoxia problem is a program to reduce nitrogen levels in the Mississippi River Basin.

2. The conflicting view highlighted by the Region 4 report is that a significant quantity of primary production (algal growth) that contributes to hypoxia occurs under a “Phosphorus Limited” condition.

   a. This view, *supported in the Region 4 report*, is that the lower Mississippi River and the Mississippi River plume along the continental shelf have high DIN/DIP ratios during high flows (spring and early summer) and are therefore not in perfect “Redfield Ratio Balance.”

   b. Consequently, Region 4 concludes that phosphorus, not nitrogen, reduction in the MRB, would be most effective in reducing the size of the Gulf hypoxic zone.

Public comments on the original Hypoxia Action Plan identified these two significantly differing views, the obvious conflict and the need to clarify the nutrient limitations issue. *Region 4 EPA, in reviewing the initial findings, concluded that little attention was paid to this conflict, nor was an attempt made to resolve it.* Farm Bureau believes resolving the conflict with regard to Redfield ratio balance and the biological bioavailability and uptake of nutrients, and consequently, determining the limiting nutrient is the most important issue to be resolved with regards to Gulf Hypoxia.

Issue #3

What type of load reductions would need to be accomplished with either nitrogen or phosphorus to accomplish a substantive reduction in hypoxia?
EPA Region 4 staff used data collected in the Mississippi and Atchafalaya Rivers and in the Gulf, with related research papers, to reevaluate the assumptions and calculations on which the original recommendation of a 30 percent reduction in nitrogen was based. The EPA Region 4 staff calculated the nutrient loads and the resultant DIN/DIP elemental ratios based on the available data and concluded that –

> “The Lower Mississippi River (LMR) and Atchafalaya River Basin (ARB) clearly deviate from stoichiometric nutrient balance. Dissolved inorganic nitrogen to dissolved inorganic phosphorus (DIN/DIP) ratios greatly exceed the Redfield ratio for N and are a factor of 3-4 higher during the high spring river flows than during summer and fall, when DIN/DIP ratios approach the Redfield ratio of 16:1. The nitrogen/phosphorus ratios for the Lower Mississippi River reported in the CENR reports were calculated using DIN and total phosphorus (TP). Using calculated DIN/DIP ratios, we have estimated the magnitude of nutrient reductions necessary to achieve DIN/DIP stoichiometric balances in the Lower Mississippi and Atchafalaya Rivers.”
>
> “Consumption of large quantities of DIN by phytoplankton in the spring probably is limited by DIP. The large quantities of DIN and TP probably are not biologically

available, which is why a moderate reduction in DIN load probably will have little benefit. During the critical late winter and spring months, DIN in the Mississippi River would have to be reduced more than 75 percent in order to achieve a 16:1 DIN/DIP ratio, and more to achieve DIN limitation. The proposed 30 percent reduction in Total Nitrogen would most likely have no impact on reducing the hypoxia area. The Box Model used to determine reductions in hypoxia area is too simple to simulate or predict the complex processes taking place in the Gulf.

> "Phosphorus appears to be the limiting factor in areas of the Gulf where phytoplankton growth is greatest, especially during the critical late winter and spring growing season. There is no convincing data that suggest that phytoplankton growth that occurs during the late summer and fall, when nitrogen limitation is more likely to occur, contributes significantly to hypoxia. To our knowledge, it has not been demonstrated that primary productivity under nitrogen limiting conditions is the major source of organic matter leading to oxygen depletion and hypoxia in the northern Gulf of Mexico. Identifying DIP as the limiting nutrient should lead to an evaluation of DIP control as an effective strategy to control eutrophication and hypoxia."

Region 4's calculations suggest a 30 percent reduction in annual average orthophosphate load would be about 13,000 metric tons, compared with a 30 percent reduction in total nitrogen of about 470,000 metric tons. However, in a phosphorus-limited system, a 30 or 40 percent reduction in nitrogen load would not be expected to reduce the size of the midsummer hypoxic zone. These findings have major policy and resource management implications and suggest that the wrong pollutant was targeted for control. A 30 percent reduction in DIN would have relatively little impact on the DIN/DIP ratio of Lower Mississippi River and Atchafalaya River Basin water discharged to the Gulf of Mexico**.** Reductions in DIN necessary to achieve "ideal Redfield ratios" (16:1) or "nitrogen limitation ratios" (10:1) are neither technically nor economically feasible nor are they warranted by the scientific evidence.

Issue #4

What are the sources of phosphorus in the appropriate basins? What additional monitoring stations need to be in place to more accurately quantify these sources?
Given data limitations, both the CENR reports and the Region 4 report are unable to adequately quantify sources of phosphorus and specifically biologically relevant orthophosphate. A new assessment is needed to identify and quantify phosphate sources, to determine the bioavailability of different forms of phosphorus, to evaluate methods, costs, feasibility and benefits of phosphorus control, and to evaluate the reductions in phosphorus loads needed to drive the system to phosphorus limitation and to reduce midsummer hypoxia. Once again, little effort has gone into adequately assessing the relative contributions of the erosion of nutrient-rich wetlands and the upwelling of nutrient laden water from the continental shelf.

The "August version" of the Region 4 report states that increasing loads of phosphorus from fertilizer use and municipal and industrial discharges are the causes of the calculated 140 percent increase in reactive phosphorus concentration in the northern Gulf since 1960, even though their data for the Mississippi River are for total phosphorus and not reactive phosphorus, and their 1960s phosphorus data are "reconstructed" and not measured. In the Midwest, the concentration of reactive phosphorous in rivers has decreased dramatically since the 1960s.

Overall, Region 4's analysis indicates that phosphate concentrations are inversely correlated with flow, while nitrogen concentrations are related to flow. Phosphate concentrations show relatively small month-to-month variation, suggesting that the phosphorus level may be largely influenced by point sources. USGS data from St. Francisville and Belle Chasse for the period 1981-1999 indicates that approximately 30 to 35 percent of the inorganic phosphorus in the river at Belle Chasse entered the river below St. Francisville during that time period, again suggesting the importance of point sources in the lower part of the river.

The Region 4 report clearly recommends more scientific research needs to be done in this area, a recommendation we fully support.

Issue #5

Which monitoring stations are most appropriate to model loading?
The Region 4 report suggests Belle Chasse. It is closer to the Gulf and will capture significant data points from point source discharges that occur between Baton Rouge and the northern Gulf. DIN and DIP at Belle Chasse – 10 miles below New Orleans - for the 1980 to 1999 period was 47:1 in the spring with a 37:1 annual average. Compared to the Redfield elemental ratio of 16:1, these results indicate the LMR at Belle Chasse is phosphorus limited.

St. Francisville (utilized by Goolsby in the original CENR assessment) is not only further from the northern Gulf, but it fails to capture significant point source discharges. Region 4 analysis of the DIN/DIP elemental ratio for the period 1980 - 1999 indicates that during the critical months of February -May there was no time when the ratio was less than 32. The Region 4 study and the monitoring data from St. Francisville suggests that the Lower Mississippi River has never been "nitrogen limited" during the winter and spring months. DIN and DIP at St. Francisville – 180 miles above New Orleans - for the 1980 to 1999 period was 60:1 in the spring and 30:1 in the fall. Compared to the Redfield elemental ratio of 16:1, these results indicate the Lower Mississippi River at St. Francisville is phosphorus limited, not nitrogen limited.

Issue #6

What is the significance of omitting transect C data for 1994, 1995, and 1997 from the original CENR reports?
Region 4 acquired data from a "NOAA website for the years, 1994, 1995, and 1997, which was part of an extensive data set on nutrient concentrations in the Gulf of Mexico, Dr. Nancy Rabalais, (Louisiana University Marine Consortium), Dr. R. Eugene Turner, (Louisiana State University), and Dr. William W. Wiseman (Louisiana State University) compiled this data through funding provided by NOAA."

The subsequent analysis by EPA "show high DIN:DIP ratios during the spring and early summer and lower ratios during the late summer and fall. The DIN: DIP ratios during the spring and late summer were often well above the Redfield ratio of 16:1, indicative of the potential for phosphorus limitation."

These data show DIN/DIP elemental ratios of 140:1 in April and May - key months for generating hypoxic conditions in summer. These data, generated by Rabalais, clearly suggest the phosphorus limitation.

Issue # 7

What was the scientific basis for the approach adopted by CENR in its original assessment and Action Plan to rely on limited monitoring data?
The exclusive use of July and August data from the northern Gulf to characterize conditions contributing to hypoxia provides an incomplete and distorted picture of the mechanisms regulating hypoxia. Basing hypoxia mitigation strategies on water quality predictions derived solely from conditions in July and August throw into question the validity of the results . In addition, the use of a simplified steady state box modeling approach calibrated to summer data is inadequate to evaluate a complex system as the Gulf. As pointed out in the Region 4 report, it is simply not reasonable to assume that processes in the Gulf are steady state or can be represented by a steady state model.

Issue #8

What other factors contribute to hypoxia in the northern Gulf of Mexico?
The Region 4 report focuses on nutrient concentrations and loads from the Mississippi/Atchafalaya River, but there are major uncertainties regarding other factors that cause or contribute to hypoxia in the northern Gulf. Given the complexity of the overall hypoxia problem, and the uncertainties that contribute to the problem, EPA must quantify the relative contribution of the following –

- Relative contribution of bio-available forms of nutrients from all sources;
- Offshore sources of nutrients from upwelled waters of the continental slope;
- Nutrient contributions associated with the loss of approximately 27 square miles of nutrient rich wetlands and coastal marshes each year;
- The change in hydrology of coastal Louisiana and the loss of wetland and coastal marshes;
- The loss of wetland filtering capacity;
- The impact of an overall increase in rainfall and increase flow patterns within the Mississippi River Basin on nutrient loads and fresh water stratification in the Gulf;
- The overall impact of flood control measures;
- The prescribed flow requirements with regard to the Atchafalaya River; and
- The impact of the capture of the Mississippi River by the Atchafalaya River on hypoxia formation in the northern Gulf of Mexico.

Conclusions – If the management measures taken to reduce hypoxia in the Gulf are based on flawed and incomplete analysis, then any remedies based upon that analysis will be suspect and likely to fail. Additional research will be needed to draw generally accepted conclusions and to improve the science necessary to understand the hypoxia issue enough to adopt a hypoxia mitigation plan that has a reasonable chance of success. A much better understanding of the sources and timing of the supply of organic matter fueling hypoxia is needed. Farmers and ranchers understand that excess nutrients can contribute to algal blooms. However, they are also aware that there are multiple sources of nutrients in watersheds, both point and non-point, and in the northern Gulf, and that the transport and delivery of these nutrients can be very complex processes.

We would like to add one note of caution. There may be a tendency on the part of some to keep the original CENR report guidelines for nitrogen reduction and simply add further guidelines or goals for phosphorous reduction. Such an approach, beginning with a conclusion not borne out by the underlying science, would be fundamentally unsound.

For a system as large and complex as the Mississippi-Atchafalaya River drainage basin and the northern Gulf of Mexico, monitoring and research should be integrated using holistic models that simulate our understanding of how the overall system functions and how management practices can best be implemented. Such holistic models include a suite of conceptual, functional, and numerical formulations; integrate research findings; and are tied to monitoring programs designed to both provide input variables and verify model outputs.

Farm Bureau appreciates the opportunity to offer these comments and recognizes that the Gulf of Mexico is experiencing a hypoxia problem. We will continue to work with the scientific community to develop and implement a plan that will help reduce the level of hypoxia. To this end the conservation title of the 2002 Farm Bill contains incentives that are helping farmers and ranchers invest in conservation practices to reduce the amount of nitrogen and phosphorous entering the Gulf. America's farmers and ranchers look forward to being part of the solution to the hypoxia situation in the Gulf of Mexico but sound science must form the basis of our evaluation and be the foundation on which solutions are determined. Agriculture remains committed to addressing local water quality challenges and will continue to implement best nutrient management practices as they provide significant farm and local benefits. Overall, without good science, we risk wasting significant public and private resources, undermining the public's confidence in conservation, environmental science and public policy, and causing more harm to the Gulf by not properly addressing its real problems.

Sincerely,

Mark Maslyn

Mark Maslyn
Executive Director
Public Policy